Calendar No. 738

108TH CONGRESS 2d Session | SENATE | REPORT 108–379

DEPARTMENT OF ENERGY HIGH-END COMPUTING REVITALIZATION ACT OF 2004

SEPTEMBER 28, 2004.—Ordered to be printed

Mr. DOMENICI, from the Committee on Energy and Natural Resources, submitted the following

R E P O R T

[To accompany H.R. 4516]

The Committee on Energy and Natural Resources, to which was referred the Act (H.R. 4516) to require the Secretary of Energy to carry out a program of research and development to advance high-end computing, having considered the same, reports favorably thereon with an amendment and recommends that the Act, as amended, do pass.

The amendment is as follows:

Strike out all after the enacting clause and insert in lieu thereof the following:

SECTION 1. SHORT TITLE.

This Act may be cited as the "Department of Energy High-End Computing Revitalization Act of 2004".

SEC. 2. DEFINITIONS.

In this Act:

(1) CENTER.—The term "Center" means a High-End Software Development Center established under section 3(d).

(2) HIGH-END COMPUTING SYSTEM.—The term "high-end computing system" means a computing system with performance that substantially exceeds that of systems that are commonly available for advanced scientific and engineering applications.

(3) INSTITUTION OF HIGHER EDUCATION.—The term "institution of higher education" has the meaning given the term in section 101(a) of the Higher Education Act of 1965 (20 U.S.C. 1001(a)).

(4) LEADERSHIP SYSTEM.—The term "Leadership System" means a high-end computing system that is among the most advanced in the world in terms of performance in solving scientific and engineering problems.

(5) SECRETARY.—The term "Secretary" means the Secretary of Energy, acting through the Director of the Office of Science of the Department of Energy.

29–010

SEC. 3. DEPARTMENT OF ENERGY HIGH-END COMPUTING RESEARCH AND DEVELOPMENT PROGRAM.

(a) IN GENERAL.—The Secretary shall—

(1) carry out a program of research and development (including development of software and hardware) to advance high-end computing systems; and

(2) develop and deploy high-end computing systems for advanced scientific and engineering applications.

(b) PROGRAM.—The program shall—

(1) support both individual investigators and multidisciplinary teams of investigators;

(2) conduct research in multiple architectures, which may include vector, reconfigurable logic, streaming, processor-in-memory, and multithreading architectures;

(3) conduct research on software for high-end computing systems, including research on algorithms, programming environments, tools, languages, and operating systems for high-end computing systems, in collaboration with architecture development efforts;

(4) provide for sustained access by the research community in the United States to high-end computing systems and to Leadership Systems, including provision of technical support for users of such systems;

(5) support technology transfer to the private sector and others in accordance with applicable law; and

(6) ensure that the high-end computing activities of the Department of Energy are coordinated with relevant activities in industry and with other Federal agencies, including the National Science Foundation, the Defense Advanced Research Projects Agency, the National Nuclear Security Administration, the National Security Agency, the National Institutes of Health, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Institutes of Standards and Technology, and the Environmental Protection Agency.

(c) LEADERSHIP SYSTEMS FACILITIES.—

(1) IN GENERAL.—As part of the program carried out under this Act, the Secretary shall establish and operate 1 or more Leadership Systems facilities to—

(A) conduct advanced scientific and engineering research and development using Leadership Systems; and

(B) develop potential advancements in high-end computing system hardware and software.

(2) ADMINISTRATION.—In carrying out this subsection, the Secretary shall provide to Leadership Systems, on a competitive, merit-reviewed basis, access to researchers in United States industry, institutions of higher education, national laboratories, and other Federal agencies.

(d) HIGH-END SOFTWARE DEVELOPMENT CENTER.—

(1) IN GENERAL.—As part of the program carried out under this Act, the Secretary shall establish at least 1 High-End Software Development Center.

(2) DUTIES.—A Center shall concentrate efforts to develop, test, maintain, and support optimal algorithms, programming environments, tools, languages, and operating systems for high-end computing systems.

(3) STAFF.—A Center shall include—

(A) a full-time research staff, to create a centralized knowledge base for high-end software development; and

(B) a rotating staff of researchers from other institutions and industry to assist in coordination of research efforts and promote technology transfer to the private sector.

(4) USE OF EXPERTISE.—The Secretary shall use the expertise of a Center to assess research and development in high-end computing system architecture.

(5) LOCATION.—The location of a Center shall be determined by a competitive proposal process administered by the Secretary.

SEC. 4. AUTHORIZATION OF APPROPRIATIONS.

In addition to amounts otherwise made available for high-end computing, there are authorized to be appropriated to the Secretary to carry out this Act—

(1) $50,000,000 for fiscal year 2005;

(2) $55,000,000 for fiscal year 2006; and

(3) $60,000,000 for fiscal year 2007.

SEC. 5. ASTRONOMY AND ASTROPHYSICS ADVISORY COMMITTEE.

(a) AMENDMENTS.—Section 23 of the National Science Foundation Authorization Act of 2002 (42 U.S.C. 1862n–9) is amended—

(1) in subsection (a) and paragraphs (1) and (2) of subsection (b), by striking "and the National Aeronautics and Space Administration" and inserting ", the

National Aeronautics and Space Administration, and the Department of Energy";

(2) in subsection (b)(3), by striking "Administration, and" and inserting "Administration, the Secretary of Energy, ";

(3) in subsection (c)—

(A) in paragraphs (1) and (2), by striking "5" and inserting "4";

(B) in paragraph (2), by striking "and" at the end;

(C) by redesignating paragraph (3) as paragraph (4), and in that paragraph by striking "3" and inserting "2"; and

(D) by inserting after paragraph (2) the following:

"(3) 3 members selected by the Secretary of Energy; and"; and

(4) in subsection (f), by striking "the advisory bodies of other Federal agencies, such as the Department of Energy, which may engage in related research activities" and inserting "other Federal advisory committees that advise Federal agencies that engage in related research activities".

(b) EFFECTIVE DATE.—The amendments made by subsection (a) take effect on March 15, 2005.

SEC. 6. REMOVAL OF SUNSET PROVISION FROM SAVINGS IN CONSTRUCTION ACT OF 1996.

Section 14 of the Metric Conversion Act of 1975 (15 U.S.C. 205*l*) is amended by striking subsection (e).

PURPOSE

The purpose of H.R. 4516 is to require the Secretary of Energy, acting through the Director of the Office of Science, to implement a research and development program (involving software and hardware) to advance high-end computing systems.

SUMMARY OF MAJOR PROVISIONS OF THE BILL

The bill requires the Secretary of Energy to develop and deploy high-end computing systems for advanced scientific and engineering applications.

The bill further requires that the Department of Energy's high-end computing (HEC) program support individual investigators and multi-disciplinary teams of investigators; conduct research on multiple computing architectures; conduct research on algorithms, programming environments, tools, languages, and operating systems; support technology transfer to the private sector; and coordinate with industry and other Federal agencies.

The bill also requires the Secretary to establish and operate Leadership Systems facilities that would provide the U.S. research community with sustained access to high-performance computing resources. (Leadership Systems are defined in the bill as high-end computing systems that are among the most advanced in the world in terms of performance in solving scientific and engineering problems.) These Leadership Systems are to be made available on a competitive, merit-reviewed basis to researchers in U.S. industry, institutions of higher education, national laboratories, and other federal agencies.

The bill requires the Secretary to establish at least one High-End Software Development Center to concentrate efforts to develop, test, maintain, and support optimized software tools for HEC. The Center is to be staffed with both full time research personnel as well as rotating staff from other organizations. The Center shall be used by the Secretary to assess research and development in HEC architectures. The location of a Center shall be determined by a competitive proposal process.

In addition to amounts otherwise made available for high-end computing, the bill authorizes the expenditure of $50 million for fiscal year 2005, $55 million for fiscal year 2006, and $60 million for fiscal year 2007.

The bill requires that the Department of Energy be included in establishment of the Astronomy and Astrophysics Advisory Committee of the National Science Foundation and the National Aeronautics and Space Administration.

The bill repeals section 14(e) of the Metric Conversion Act of 1975 (15 U.S.C. 205*l*(e)) so as to remove a sunset provision from the Savings in Construction Act of 1996; by so doing, it continues requirements that specifications for masonry and light fixtures for use in Federal facilities shall not be written so as to be satisfied only with metric versions unless the need for such "hard metric" specifications is certified by the head of the relevant Federal agency.

BACKGROUND AND NEED

High-performance computers are used to simulate physical phenomena that are either too difficult or too costly to study experimentally. These simulations provide insight into physical phenomena and in some cases are the only alternatives to experiments. They provide a critical ability to accelerate progress in fundamental sciences. The applications of high-performance computing extend far beyond scientific advances. Global leadership in high performance computing is an essential component of national security and economic competitiveness.

Historically, the United States has driven advances in high performance computing and, in most past years, the world's fastest computers were located here. But today, the world's fastest computer is Japan's Earth Simulator. The Earth Simulator has held this distinction for well over two years, an extremely long time in the rapidly improving and evolving computational arena. The Earth Simulator is slightly more than 2.5 times faster than the next fastest computer in the world, which is located in the United States. While 15 of the top 20 high-performance computers are currently located here, the fact remains that the Earth Simulator has dramatically changed the metrics for high-performance computing.

The Advanced Scientific Computing Research (ASCR) program in the Office of Science supports fundamental research in applied mathematics, computer science, and networking. The Office also provides world-class, high-performance computational tools that enable the DOE to succeed in its science, energy, environmental remediation, and national security missions. The mission of this program is to underpin the Department's world leadership in scientific computation. It does not include a substantial budget for new facilities.

This legislation authorizes the Secretary of Energy, acting through the Department's Office of Science, to carry out a research and development program to put our nation on the forefront of high-performance computing. This act authorizes the Secretary of Energy to establish scientific computing facilities and a high-end software development center.

This legislation is consistent with observations of the National Research Council in its interim report on the future of supercomputing, which addressed the need for government involvement:

> There are several important arguments for government involvement in the advancement of supercomputers and their applications. The first is that unique supercomputing technologies are needed to perform essential government missions and to ensure that critical national security requirements are met. Furthermore, without the government's involvement, market forces are unlikely to drive sufficient innovation in supercomputing, because the innovators—like innovators in many other high-technology areas—do not capture the full value of their innovations. Historically, it seems that innovations in supercomputing have played an important role in the evolution of today's mainstream computers and have provided important benefits by virtue of their use in science and engineering. These benefits seem to significantly exceed the value captured by the initial inventors.

H.R. 4516 authorizes the Department to support research to develop and build the next generation of computer architectures and the software to operate and use these next generation machines.

Legislative History

S. 2176 was introduced on March 8, 2004, by Senator Bingaman on behalf of himself and Senator Alexander. The companion bill, H.R. 4516, was introduced on June 4, 2004 by Rep. Judy Biggert; passed as amended by the House on July 7, 2004; and received in the Senate on July 8, 2004.

On June 22, 2004, the Committee on Energy and Natural Resources, Subcommittee on Energy held a hearing on High-Performance Computing: Regaining U.S. Leadership, which included consideration of S. 2176, the High-End Computing Revitalization Act of 2004.

The Committee on Energy and Natural Resources ordered H.R. 4516, as amended, favorably reported on September 15, 2004.

Committee Recommendation

The Committee on Energy and Natural Resources, in an open business meeting on September 15, 2004, by a unanimous voice vote of a quorum present, recommends that the Senate pass H.R. 4516, if amended as described herein.

Committee Amendment

The amendment in the nature of a substitute made few changes to H.R. 4516 as passed by the House. One definition was modified to require the Secretary to act through the Director of the Office of Science. Provisions for at least one software development center were added to the program functions. The National Nuclear Security Administration was added to groups whose programs were to be coordinated. No change was made in authorization levels or fiscal years. Section 5 on Societal Implications of Information Technology was deleted.

The amendment in the nature of a substitute differs from S. 2176 in several ways. Section 2, Findings, was deleted. Section 3, Definitions, had minimal changes, including substitution of the term "leadership system" for "ultrascale scientific computing capability." Program functions remained similar; reference to classified facilities was deleted. Levels and duration of authorizations in Section 5 were reduced substantially to match the levels and duration as passed by the House. Sections 6 and 7 of H.R. 4516 as passed by the House were incorporated.

SECTION-BY-SECTION ANALYSIS

Section 1. Short title

Department of Energy High-End Computing Revitalization Act of 2004.

Section 2. Definitions

Defines terms used in the Act, including:

Center: The term "Center" means a High-End Software Development Center established under section 3(d).

High-end computing system: the term "high-end computing system" means a computing system with performance that substantially exceeds systems that are commonly available for advanced scientific and engineering applications;

Leadership System: the term "Leadership System" means a high-end computing system that is among the most advanced in the world in terms of performance in solving scientific and engineering problems.

Institution of Higher Education: the term "institution of higher education" has the meaning given the term in section 101(a) of the Higher Education Act of 1965 (20 U.S.C. 1001(a)).

Secretary: the term "Secretary" means the Secretary of Energy acting through the Director of the Office of Science.

Section 3. Department of Energy high-end computing research and development program

Requires the Secretary of Energy to carry out a high-end computing (HEC) research and development program. Requires the Secretary to develop and deploy HEC systems for advanced scientific and engineering systems. Requires the program to:

- Support both individual investigators and multidisciplinary teams of investigators;
- Conduct research on multiple HEC architectures;
- Conduct research in algorithms, programming environments, tools, languages, and operating systems for HEC systems in collaboration with architecture development efforts;
- Provide for sustained access by the research community in the United States to HEC systems and to Leadership Systems, including the provision of technical support for users of such systems;
- Support technology transfer to the private sector; and
- Ensure that Department of Energy HEC activities are coordinated with industry and with other Federal agencies.

Requires the Secretary to establish and operate Leadership Systems facilities to conduct advanced scientific and engineering research and development using Leadership Systems, and to develop potential advancements in HEC system hardware and software. Requires the Secretary to provide access to Leadership Systems on competitive, merit-reviewed basis to researchers in United States industry, institutions of higher education, national laboratories, and other Federal agencies.

Requires the Secretary to establish at least one High-End Software Development Center that is to concentrate efforts to develop, test, maintain, and support optimized software tools for HEC. The Center is to be staffed with both full time research personnel as well as rotating staff from other organizations. The Center shall be used by the Secretary to assess research and development in HEC architectures. The location of a Center shall be determined by a competitive proposal process.

Section 4. Authorization of appropriations

Authorizes appropriations to the Secretary of Energy to carry out this Act of $50,000,000 for fiscal year 2005; $55,000,000 for fiscal year 2006; and $60,000,000 for fiscal year 2007.

Section 5. Astronomy and Astrophysics Advisory Committee

Adds the Department of Energy to the jointly established (by the National Science Foundation and the National Aeronautics and Space Administration) Astronomy and Astrophysics Advisory Committee.

Section 6. Removal of Sunset Provision from Savings in Construction Act of 1996

Repeals Section 14(e) of the Metric Conversion Act of 1975 (15 U.S.C. 205 *l*(e)) so as to remove a sunset provision from the Savings in Construction Act of 1996; by so doing, it continues requirements that specifications for masonry and light fixtures for use in Federal facilities shall not be written so as to be satisfied only with metric versions unless the need for such "hard metric" specifications is certified by the head of the relevant Federal agency.

COST AND BUDGETARY CONSIDERATIONS INCLUDING CONGRESSIONAL BUDGET OFFICE ESTIMATES

The following estimate of the cost of this measure has been provided by the Congressional Budget Office:

H.R. 4516—Department of Energy High-End Computing Revitalization Act of 2004

Summary: H.R. 4516 would authorize the appropriation of $165 million to the Department of Energy (DOE) over fiscal years 2005 through 2007 for certain activities related to high-end computing systems. The act would direct DOE to conduct research and development (R&D) on ways to advance the capabilities of high-end computing systems and to establish and operate leadership-class facilities, as well as to establish at least one High-End Software Development Center for the purpose of developing and supporting associated software. The act would define high-end computing systems to include those computing systems that substantially exceed the performance of systems commonly available for scientific and engineering applications. Leadership systems would be those whose performance is among the most advanced in the world.

CBO estimates that implementing H.R. 4516 would cost $165 million over the 2005–2009 period, assuming appropriation of the authorized amounts. Enacting H.R. 4516 would have no effect on direct spending or revenues.

H.R. 4516 contains no intergovernmental or private-sector mandates as defined in the Unfunded Mandates Reform Act (UMRA) and would impose no costs on state, local, and tribal governments.

Estimated cost to the Federal Government: The estimated budgetary impact of H.R. 4516 is shown in the following table. For this estimate, CBO assumes that the legislation will be enacted near the start of 2005 and that the amounts specified in the act will be appropriated near the beginning of each fiscal year. We assume that outlays will follow historical patterns for DOE research and development activities. The costs of this legislation fall within budget function 250 (general science, space, and technology).

	By fiscal year, in millions of dollars—					
	2004	2005	2006	2007	2008	2009
SPENDING SUBJECT TO APPROPRIATION						
Spending under current law for DOE R&D on certain high-end computing systems:						
Budget authority [1]	38	0	0	0	0	0
Estimated outlays	19	17	2	0	0	0
Proposed changes:						
Authorization level	0	50	55	60	0	0
Estimated outlays	0	25	50	57	30	3
Spending under H.R. 4516:						
Authorization level [1]	38	50	55	60	0	0
Estimated outlays	19	42	52	57	30	3

[1] The 2004 level is the amount that the Office of Management and Budget estimates was appropriated for activities similar to those authorized in H.R. 4516.

Intergovernmental and private-sector impact: H.R. 4516 contains no intergovernmental or private-sector mandates as defined in UMRA and would impose no costs on state, local, and tribal governments.

Previous CBO Estimate: On June 24, 2004, CBO transmitted a cost estimate for H.R. 4516 as ordered reported by the House Committee on Science on June 16, 2004. The two versions of the legislation are similar. However, the Senate version would add the requirement to establish at least one High-End Software Development Center while leaving the authorized appropriation levels the same as in the House version.

Estimate prepared by: Federal Costs: Mike Waters; Impact on State, Local, and Tribal Governments: Greg Waring; and Impact on the Private Sector: Jean Talarico.

Estimate approved by: Peter H. Fontaine, Deputy Assistant Director for Budget Analysis.

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in carrying out H.R. 4516.

The bill is not a regulatory measure in the sense of imposing Government established standards or significant economic responsibilities on private individuals and businesses.

No personal information would be collected in administering the program. Therefore, there would be no impact on personal privacy.

Little, if any, additional paperwork would result from the enactment of H.R. 4516.

EXECUTIVE COMMUNICATIONS

On September 20, 2004, the Committee on Energy and Natural Resources requested legislative reports from the Department of Energy and the Office of Management and Budget setting forth Executive agency recommendations on H.R. 4516. These reports had not been received when this report was filed.

The following testimony was presented on behalf of the Executive Branch at the June 22, 2004 Subcommittee Hearing by Dr. James Decker, Principal Deputy Director of the Office of Science of the Department of Energy.

STATEMENT OF DR. JAMES F. DECKER, PRINCIPAL DEPUTY DIRECTOR, OFFICE OF SCIENCE, U.S. DEPARTMENT OF ENERGY

Mr. Chairman and members of the Committee, I commend you for holding this hearing—and I appreciate the opportunity to testify on behalf of the Department of Energy's (DOE) Office of Science, on a subject of central importance to this Nation: advanced supercomputing capability for science.

The Bush Administration has recognized the need for the U.S. to emphasize the importance of high-end computing and is working as a team to address it. The Administration commissioned an interagency study by the High End Computing Revitalization Task Force (HECRTF). The HECRTF report (http://www.itrd.gov/pubs/2004_hecrtf/20040510_hecrtf.pdf) reinforces the idea that no one agency can—or should—be responsible for ensuring that our scientists have the computational tools they need to do their job, but duplication of effort must be avoided.

Through the efforts of DOE's Office of Science and other federal agencies, we are working to implement the recommendations of the HECRTF Report by investing in the development of the next generation of supercomputer architectures, as well as the networks to enable widespread access to these new supercomputers.

On May 12th of this year, Secretary Spencer Abraham announced that the DOE will grant Oak Ridge National Lab (ORNL), Argonne National Lab, Pacific Northwest National Lab and its development partners, Cray, IBM and SGI, $25 million in funding to begin to build a new supercomputer for scientific research. The Department selected ORNL from four proposals received from its non-weapon national labs. The Department is in the final stages of completing this award and expects to start the project before the end of this fiscal year.

Computational modeling and simulation rank among the most significant developments in the practice of scientific inquiry in the latter half of the 20th century and are now a major force for discovery in their own right. In the past century, scientific research was extraordinarily successful in identifying the fundamental physical laws that govern our material world. At the same time, the advances promised by these discoveries have not been fully realized, in part because the real-world systems governed by these physical laws are extraordinarily complex. Computers help us visualize, test hypotheses, guide experimental design, and most importantly determine if there is consistency between theoretical models and experiment. Computer-based simulation provides a means for predicting the behavior of complex systems that can only be described empirically at present. Since the development of digital computers in mid-century, scientific computing has greatly advanced our understanding of the fundamental processes of nature, e.g., fluid flow and turbulence in physics, molecular structure and reactivity in chemistry, and drug-receptor interactions in biology. Computational simulation has even been used to explain, and sometimes predict, the behavior of such complex natural and engineered systems as weather patterns and aircraft performance.

Within the past two decades, scientific computing has become a contributor to essentially all scientific research programs. It is particularly important to the solution of research problems that are (i) insoluble by traditional theoretical and experimental approaches, e.g., prediction of future climates or the fate of underground contaminants; (ii) hazardous to study in the laboratory, e.g., characterization of the chemistry of radionuclides or other toxic chemicals; or (iii) time-consuming or expensive to solve by traditional means, e.g., development of new materials, determination of the structure of proteins, understanding plasma instabilities, or exploring the limitations of the "Standard Model" of particle physics. In many cases, theoretical and experimental approaches do not provide sufficient information to understand and predict the behavior of the systems being studied. Computational modeling and simulation, which allows a description of the system to be constructed from basic theoretical principles and the available experimental data, are keys to solving such problems.

We have moved beyond using computers to solve very complicated sets of equations to a new regime in which scientific simulation enables us to obtain scientific results and to perform discovery in the same way that experiment and theory have traditionally been used to accomplish those ends. We must think of computation as the third of the three pillars that support scientific discovery, and indeed there are areas where the only approach to a solution is through high-end computation.

Combustion is the key source of energy for power generation, industrial process heat and residential applications. In all of these areas, combustion occurs in a turbulent environment. Although experimental and theoretical investigations have been able to provide substantial insights into turbulent flame dynamics, fundamental questions about flame behavior remain unanswered. Current limitations in computational power do not allow combustion scientists to address the range of conditions needed to have environmental and economic impact. Leadership class computers should enable us to model more complex fuels with emission chemistry under conditions typical of industrial settings. These computations should make it possible to design new low-emission burners that could dramatically reduce NO_X emissions.

The Fusion Program must be able to model an experiment the size of the International Thermonuclear Experimental Reactor (ITER) through the duration of a discharge that may last on the order of hundreds of seconds. Current codes are able to model a variety of the physical phenomena that occur in small experiments operating on a millisecond time scale. Leadership class computers should enable scientists to simulate burning plasmas in ITER and include new physics such as more realistic treatment of electron dynamics and multiple species of fusion products such as high energy alpha particles.

High-end computing must be coupled with high-performance networks to fully realize its potential. These networks play a critical role because they make it possible to overcome the geographical distances that often hinder science. They make vast scientific resources available to scientists, regardless of location, whether they are at a university, national laboratory, or industrial setting. We work with the National Science Foundation and university consortia such as Internet 2 to ensure that scientists at universities can seamlessly access unique DOE facilities and their scientific partners in DOE laboratories.

In addition, the emergence of high-performance computers as tools for science, just like our light sources, accelerators and neutron sources, has changed the way in which science is conducted. Today and in the future, large multidisciplinary teams are needed to make the best use of computers as tools for science. These teams need access to significant allocations of computer resources to perform leading edge science. In the Office of Science we are building on the experience of the National Nuclear Security Administration's Office of Advanced Simulation and Computing program to build and manage these teams.

The astonishing speeds of new high-end machines, including the Earth Simulator, should allow computation to inform our approach to science. We are now able to contemplate exploration of worlds never before accessible to mankind. Previously, we used computers to solve sets of equations representing physical laws too complicated to solve analytically. Now we can simulate systems to discover physical laws for which there are no known predictive equations. We can model physical structures with hundreds of thousands, or maybe even millions, of "actors" interacting with one another in a complex fashion. The speed of our new computational environment allows us to test different inter-actor relations to see what macroscopic behaviors can ensue. Simulations can help determine the nature of the fundamental “forces” or interactions between “actors.”

The ASCR program mission is to discover, develop, and deploy the computational and networking tools that enable scientific researchers to analyze, model, simulate, and predict complex phenomena important to the Department of Energy—and to the U.S. and the world.

Advanced scientific computing is central to DOE’s missions. It is essential to simulate and predict the behavior of nuclear weapons and aid in the discovery of new scientific knowledge.

As the lead government funding agency for basic research in the physical sciences, the Office of Science has a special responsibility to ensure that its research programs continue to advance the frontiers of science. This requires significant enhancements to the Office of Science’s scientific computing programs. These include both more capable computing platforms and the development of the sophisticated mathematical and software tools required for large-scale simulations.

Existing highly parallel computer architectures, while extremely effective for many applications, including solution of some important scientific problems, are only able to operate at 5–10% of their theoretical maximum capability on other applications. For most vendors, today’s high performance computer market is too small a fraction of the overall market to justify the level of R&D needed to ensure development of computers that can solve the most challenging scientific problems or the substantial investments needed to validate their effectiveness on industrial problems.

Therefore, we are working in partnership with the National Nuclear Security Administration (NNSA), the National Security Agency (NSA), and the Defense Advanced Research Project Agency (DARPA) to identify architectures which are most effective in solving specific types of problems; to evaluate the effectiveness of various different existing computer architectures; and to spur the development of new architectures tailored to the requirements of science and national security applications.

This partnership is working to ensure the development of computers that can meet the most demanding Federal missions in science and national security. We are also working to transfer the knowledge we develop to U.S. industry to enable a vibrant U.S. high performance computing industry, which can provide the impetus for economic growth and competitiveness across the nation. The Office of Science plays a key role in providing these capabilities to the open science community to support U.S. scientific leadership, just as we do with other facilities for science.

Advanced scientific computing will continue to be a key contributor to scientific research in the 21st century. Major scientific challenges in all Office of Science research programs will be addressed by advanced scientific supercomputing. Designing materials atom-by-atom, revealing the functions of proteins, understanding and controlling fusion plasma turbulence, designing new particle accelerators, and modeling global climate change, are just a few examples.

In fact, in fulfilling its mission over the years, the Office of Science has played a key role in maintaining U.S. leadership in scientific computation and networking worldwide. Consider some of the innovations and contributions made by DOE's Office of Science:

• Helped develop the Internet;

• Pioneered the transition to massively parallel supercomputing in the civilian sector;

• Began the computational analysis of global climate change;

• Developed many of the computational technologies for DNA sequencing that have made possible the unraveling of the human genetic code.

Various computational scientists have said that discovery through simulation requires sustained speeds starting at 50 teraflops to examine a subset of challenging problems in accelerator science and technology, astrophysics, biology, chemistry and catalysis, climate prediction, combustion, computational fluid dynamics, computational structural and systems biology, environmental molecular science, fusion energy science, geosciences, groundwater protection, high energy physics, materials science and nanoscience, nuclear physics, soot formation and growth, and more.

The Office of Science also is a leader in research efforts to capitalize on the promise of nanoscale science and biotechnology. This revolution in science promises a revolution in industry.

To develop systems capable of meeting the challenges faced by DOE, universities, and industry, the Office of Science invests in several areas of computation: high-performance computing, large-scale networks, and the software that enables scientists to use these resources as tools for discovery. The FY 2005 President's Request for the Office of Science includes $204 million for ASCR for IT R&D and approximately $20 million in the other Offices to support the development of the next generation of scientific simulation software for SC mission applications.

As a part of this portfolio the Office of Science supports basic research in applied mathematics and the computer science needed to underpin advances in high performance computers and networks for science.

In FY 2001 the Office of Science initiated the Scientific Discovery through Advanced Computing (www.science.doe.gov/SciDAC/) effort to leverage our basic research in mathematics and computer science and integrate this research into the scientific teams that extend the frontiers of science across DOE–SC. We have assembled interdisciplinary teams and collaborations to develop the necessary state-of-the-art mathematical algorithms and software, supported by appropriate hardware and middleware infrastructure, to use terascale computers effectively to advance fundamental scientific research at the core of DOE's mission.

All of these research efforts, as well as the success of computational science across SC, depend on a portfolio of high performance computing facilities and test beds and on the high performance networks that link these resources to the scientists across the country. DOE and the Office of Science have been leaders in testing and evaluating new high performance computers and networks and turning them into tools for scientific discovery since the early 1950s. The Office of Science established the first national civilian supercomputer center, the Magnetic Fusion Energy Computer Center, in 1975. We have tested and evaluated early versions of computers ranging from the first Cray 1s to the parallel architectures of the 1990s to the Cray X1 at ORNL. In many cases these systems would not have existed without the Office of Science as a partner with the vendors. Our current facilities and test beds include:

- The Center for Computational Sciences (CCS) at Oak Ridge National Laboratory, has been testing and evaluating leading edge computer architectures as tools for science for over a decade. The latest evaluation is on a Cray X1 formed the basis for ORNL's successful proposal to begin developing a leadership class computing capability for the U.S. open scientific community. In his remarks announcing the result of this competition, Secretary of Energy Spencer Abraham stated, "This new facility will enable the Office of Science to deliver world leadership-class computing for science," and "will serve to revitalize the U.S. effort in high-end computing." This supercomputer will be open to the scientific community for research.
- The National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory, which provides leading edge high-performance computing services to over 2,000 scientists nationwide. NERSC has a 6,000 processor IBM SP3 computer with a peak speed of 10 TeraFLOPS. We have initiated a new program at NERSC, Innovative and Novel Computational Impact on Theory and Experiment (INCITE), to allocate substantial computing resources to a few, competitively selected, research proposals from the national scientific community. Last year, I selected three proposals for INCITE. One of these has successfully simulated the explosion of a supernova in 3–D for the first time.
- The Energy Sciences Network (ESnet), which links DOE facilities and researchers to the worldwide research community. ESnet works closely with other Federal research networks and with university consortia such as Internet 2 to provide seamless connections from DOE to other research communities. This network must address facilities that produce millions of gigabytes (petabytes) of

data each year and deliver these data to scientists across the world.

We have learned important lessons from these test beds. By sharing our evaluations with vendors we have enabled them to produce better products to meet critical scientific and national security missions. Our spending complements commercial R&D in IT which is focused on product development and on the demands of commercial applications which generally place different requirements on the hardware and software than do leading edge scientific applications.

The Office of Science coordinates with other federal agencies to avoid duplication of efforts. In the areas where the Office of Science (DOE–SC) focuses its research—High-End Computing and Large Scale Networking—DOE–SC co-chairs the relevant federal coordinating group. In addition to this mechanism, DOE–SC has engaged in a number of other joint planning and coordination efforts.

- DOE–SC participated in the National Security community planning effort to develop an Integrated High End Computing plan.
- DOE–SC and DOD co-chaired the HECRTF.
- DOE–SC and NSF co-chair the Federal teams that coordinate the engineering of Federal research networks and the emerging GRID Middleware.
- DOE–SC is a partner with DARPA in the High Productivity Computing Systems project, which will deliver the next generation of advanced computer architectures for critical science and national security missions through partnerships with U.S. industry.
- DOE–SC works closely with NNSA on critical software issues for high performance computing.
- DOE–SC, DOE–NNSA, DOD–ODDR&E, DOD–NSA, and DOD–DARPA have developed a Memorandum of Understanding to jointly plan our research in high performance computing. This MOU will enable us to better integrate our substantial ongoing collaborative projects.

High-end computing is a key tool in carrying out Federal agency missions in science and technology, but the high end computer market is simply not large enough to divert computer industry attention from the much larger and more lucrative commerce and business computing sector. The federal government must perform the research and prototype development on the next generation of tools to meet those needs. This next generation of computers, however, might also serve to benefit industry.

Mr. Chairman, high-performance computing provides a new window for researchers to understand the natural world with a precision that could only be imagined a few years ago. Research investments in advanced scientific computing will equip researchers with premier computational tools to advance knowledge and to help solve the most challenging scientific problems facing the Nation.

With vital support from this Committee, the Congress and the Administration, we in the Office of Science hope to continue to play an important role in the world of scientific supercomputing.

Thank you very much.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, changes in existing law made by H.R. 4516, as ordered reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italic, existing law in which no change is proposed is shown in roman):

Public Law 107–368, 107th Congress

AN ACT To authorize appropriations for fiscal years 2003, 2004, 2005, and 2007 for the National Science Foundation, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "National Science Foundation Authorization Act of 2002".

* * * * * * *

SEC. 23. ASTRONOMY AND ASTROPHYSICS ADVISORY COMMITTEE.

(a) ESTABLISHMENT.—The Foundation [and the National Aeronautics and Space Administration]*, the National Aeronautics and Space Administration, and the Department of Energy* shall jointly establish an Astronomy and Astrophysics Advisory Committee (in this section referred to as the "Advisory Committee").

(b) DUTIES.—The Advisory Committee shall—

(1) assess, and make recommendations regarding, the coordination of astronomy and astrophysics programs of the Foundation [and the National Aeronautics and Space Administration]*, the National Aeronautics and Space Administration, and the Department of Energy*;

(2) assess, and make recommendations regarding, the status of the activities of the Foundation [and the National Aeronautics and Space Administration]*, the National Aeronautics and Space Administration, and the Department of Energy* as they relate to the recommendations contained in the National Research Council's 2001 report entitled "Astronomy and Astrophysics in the New Millennium", and the recommendations contained in subsequent National Research Council reports of a similar nature; and

(3) not later than March 15 of each year, transmit a report to the Director, the Administrator of the National Aeronautics and Space [Administration, and] *Administration, the Secretary of Energy,* the Committee on Science of the House of Representatives, the Committee on Commerce, Science, and Transportation of the Senate, and the Committee on Health, Education, Labor, and Pensions of the Senate on the Advisory Committee's findings and recommendations under paragraphs (1) and (2).

(c) MEMBERSHIP.—The Advisory Committee shall consist of 13 members, none of whom shall be a Federal employee, including—

(1) 【5】 *4* members selected by the Director;

(2) 【5】 *4* members selected by the Administrator of the National Aeronautics and Space Administration; 【and】

(3) 3 members selected by the Secretary of Energy; and

【(3)】 *(4)* 【(3)】 *2* members selected by the Director of the Office of Science and Technology Policy.

(d) SELECTION PROCESS.—Initial selections under subsection (c) shall be made within 3 months after the date of the enactment of this Act. Vacancies shall be filled in the same manner as provided in subsection (c).

(e) CHAIRPERSON.—The Advisory Committee shall select a chairperson from among its members.

(f) COORDINATION.—The Advisory Committee shall coordinate with 【the advisory bodies of other Federal agencies, such as the Department of Energy, which may engage in related research activities】 *other Federal advisory committees that advise Federal agencies that engage in related research activities.*

* * * * * * *

Public Law 94–168, as Amended by Public Law 104–289

AN ACT To declare a national policy of coordinating the increasing use of the metric system in the United States, and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Metric Conversion Act of 1975".

* * * * * * *

SEC. 14. IMPLEMENTATION IN ACQUISITION OF CONSTRUCTION SERVICES AND MATERIALS FOR FEDERAL FACILITIES.

(a) * * *

* * * * * * *

【(e) EXPIRATION.—The provisions contained in subsections (b) and (c) of this section shall expire 10 years from the effective date of the Savings in Construction Act of 1996.】

* * * * * * *

○